



Utilising higher resolution satellite sensors to produce 2 km multi-sensor composites of sea surface temperature

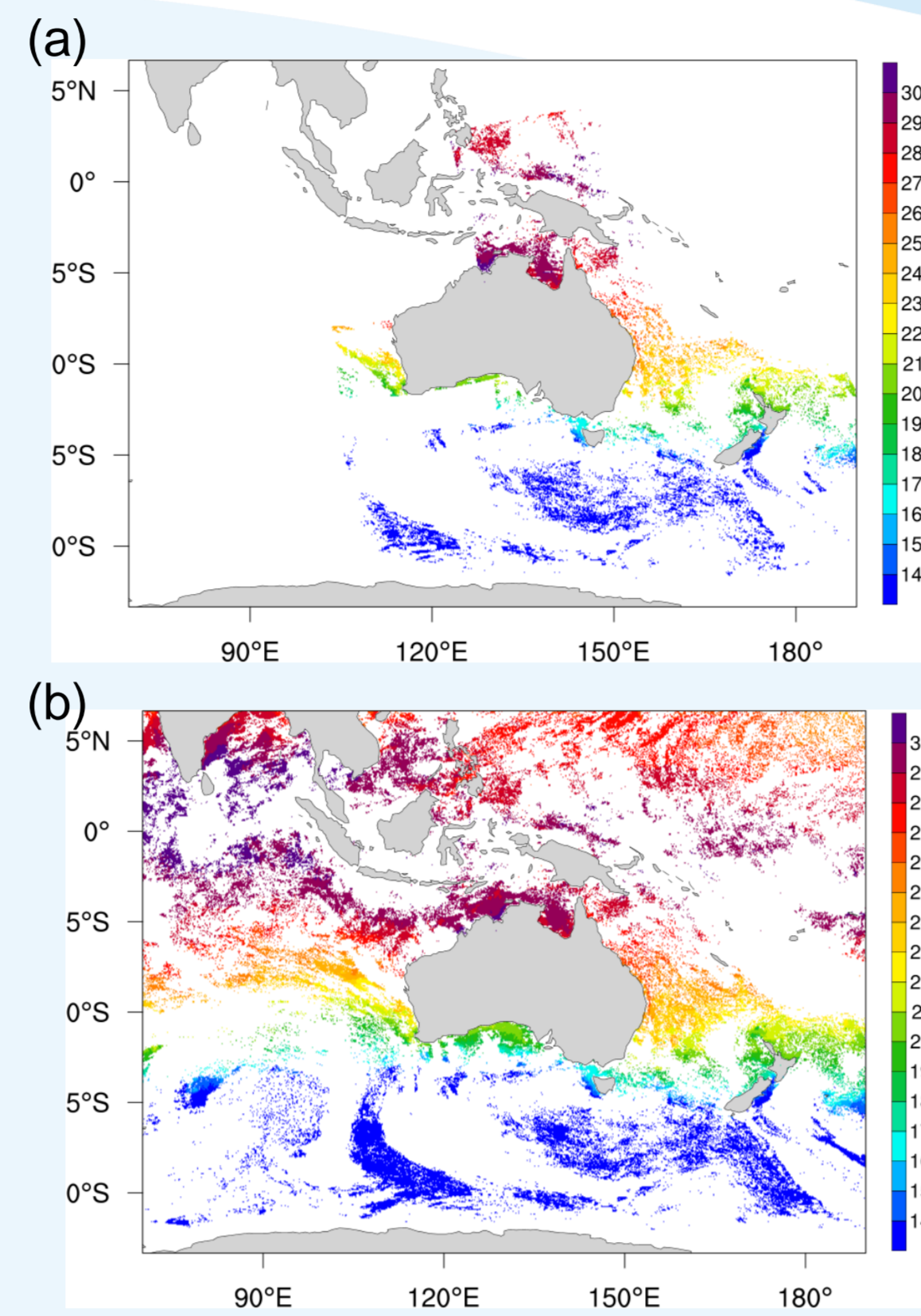


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Introduction

As part of the Integrated Marine Observing System (IMOS), the Australian Bureau of Meteorology (BoM) has produced GHRSSST L2P and 0.02° gridded L3U, L3C and L3S Sea Surface Temperature (SST) products over two domains (Australia and Southern Ocean) for the period 1992 to present. BOM has produced L3S SST products using 1 - 4 km resolution High Resolution Picture Transmission (HRPT) data from Advanced Very High-Resolution Radiometer (AVHRR) sensors on NOAA Polar Orbiting Environmental Satellites (NOAA-11 to NOAA-19). From 21st November 2018, BOM has additionally produced operational Multi-Sensor L3S products that are constructed by compositing SST from AVHRR sensors on NOAA-18 and 0.75 - 1.5 km resolution SST from Visible Infrared Imaging Radiometer Suite (VIIRS) sensors on Suomi National Polar-orbiting Partnership (Suomi-NPP). BOM now also produces experimental 0.02° x 0.02° Multi-sensor L3S SST products over single to multi-day scales by compositing SST from AVHRR sensors on MetOp-A, MetOp-B, NOAA-15, NOAA-18 and NOAA-19, along with SST from VIIRS sensors on Suomi-NPP and NOAA-20 polar-orbiting satellites. In addition to 1-day single sensor L3C composites of SST from these polar-orbiters, experimental sub-day scale single sensor L3C products are also produced from Himawari-8 SST.

Fig.1 Sea Surface Temperature with quality level 4 and 5 for operational L3S 1-day night file from (a) AVHRR only (NOAA-18) (b) Multi-sensor (NOAA-18+Suomi NPP) for 13th April 2019.



Quality Remapping and Data Composition

- The IMOS HRPT AVHRR L2P, ACSP0 VIIRS L3U and EUMETSAT FRAC AVHRR L2P files are used to construct IMOS L3U files for NOAA-18, Suomi-NPP, NOAA-20 and MetOp-B satellite sensors.

- In order to merge data from different satellite sensors, the quality level of each dataset to be merged is redefined as the minimum of the original quality level provided by the data provider and quality level calculated using Sensor Specific Error Statistics (SSES). The latter is calculated using SSES bias (μ_{SSES}) and SSES standard deviation (σ_{SSES}) estimates.

$$q_{SSES} = \frac{1}{\sqrt{2}} \sqrt{\max\left(\left(\frac{\sigma_{SSES}}{\sigma_0}\right)^2 + \left(\frac{\mu_{SSES} - \mu_0}{\sigma_{SSES}}\right)^2 - 1, 0\right)}$$

$$q_s = \lceil 5 \exp^{q_{SSES}} \rceil$$

Different data sources can then be combined using q_s , provided that $\eta/\sigma_0 = \text{constant}$

- Merged L3C SST over a given time period and location is defined as the weighted average of the best quality source L3U pixels on the IMOS 0.02 degree grid.

- The data from NOAA-18, Suomi NPP, NOAA-20 and MetOp-B L3C data are composited using an equal weighted averaging method to construct the new experimental Multi-sensor L3S product.

Adding 1-4 km MetOp-B FRAC AVHRR SST data (Fig 2a) and NOAA-20 VIIRS SST data (Fig 2b) to existing data streams for operational Multisensor L3S (NOAA-18 and Suomi NPP, Fig 1b), shows significant improvement in spatial coverage (Fig 3).

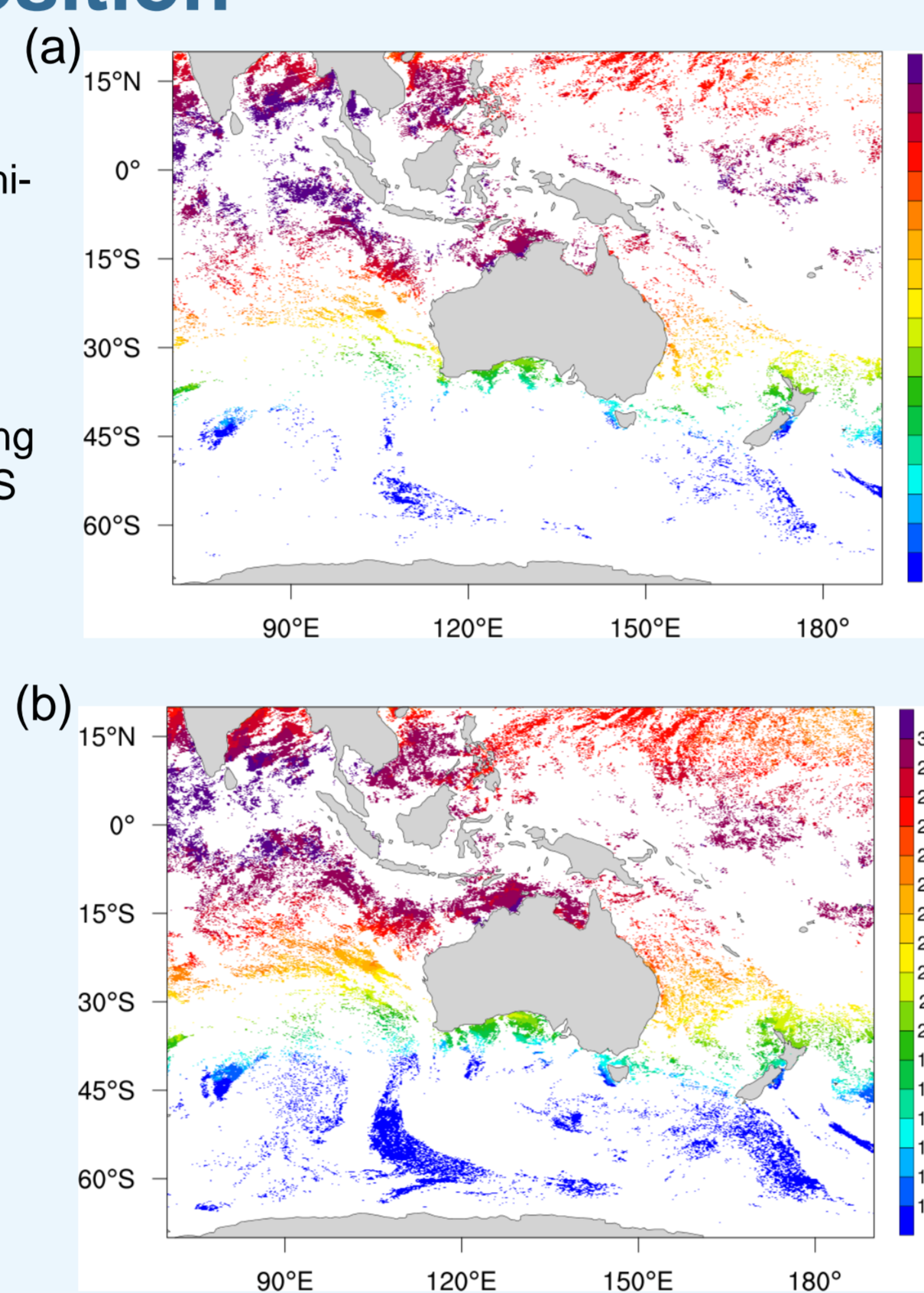


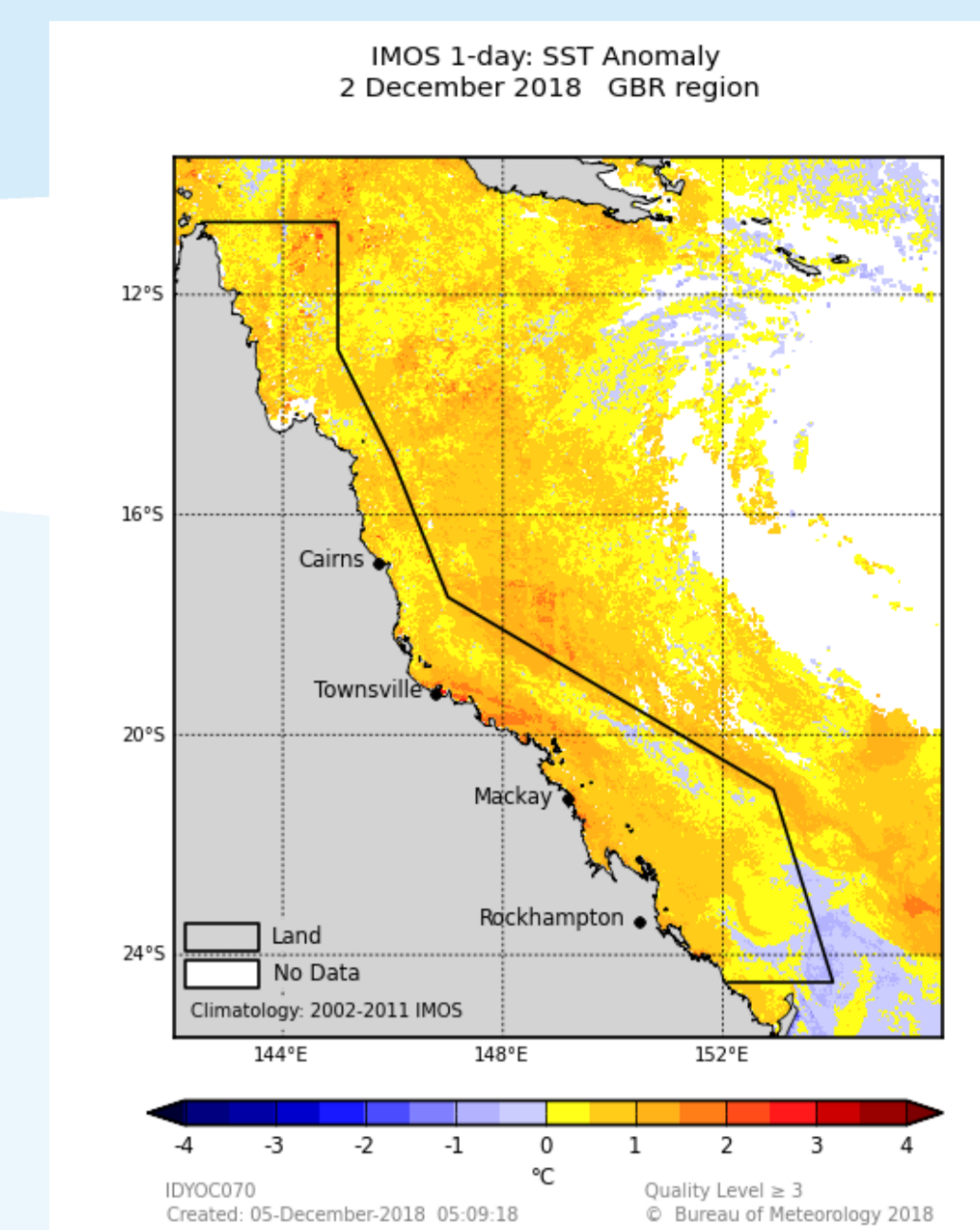
Fig 2. Sea Surface Temperature from L3C 1-day Night file for (a) MetOp-B and (b) NOAA-20 on 13th April 2019.

Applications

Nowcasting coral bleaching:

ReefTemp NextGen uses night-only 1-day L3S Near Real Time maps of SST to provide information on coral bleaching risk for the Great Barrier Reef region.
<http://www.bom.gov.au/environment/activities/reeftemp/reeftemp.shtml>

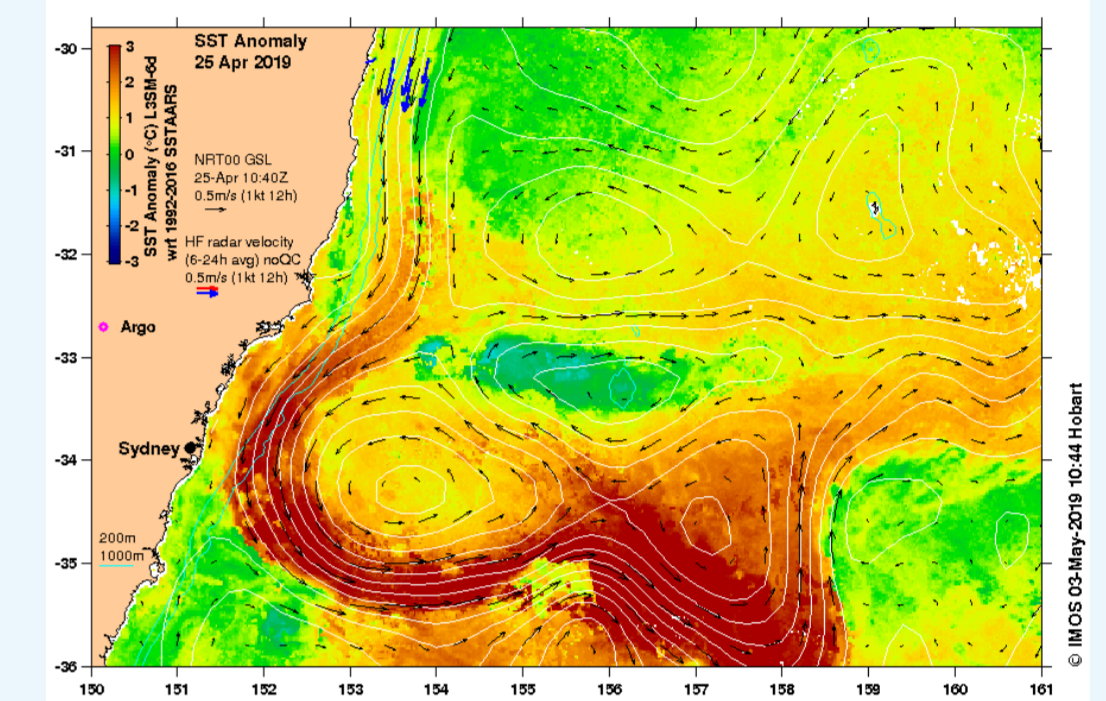
Fig. 6. BoM ReefTemp NextGen map of the 2 km SST anomaly for 2nd December 2018 off the Queensland coast, Australia, generated using IMOS night-only 1-day Multi-sensor L3S SSTs.



Nowcasting Marine Heat Waves:

IMOS OceanCurrent uses night-only 1/3/6-day L3S and night-only 1-month L3S
<http://oceancurrent.imos.org.au/>

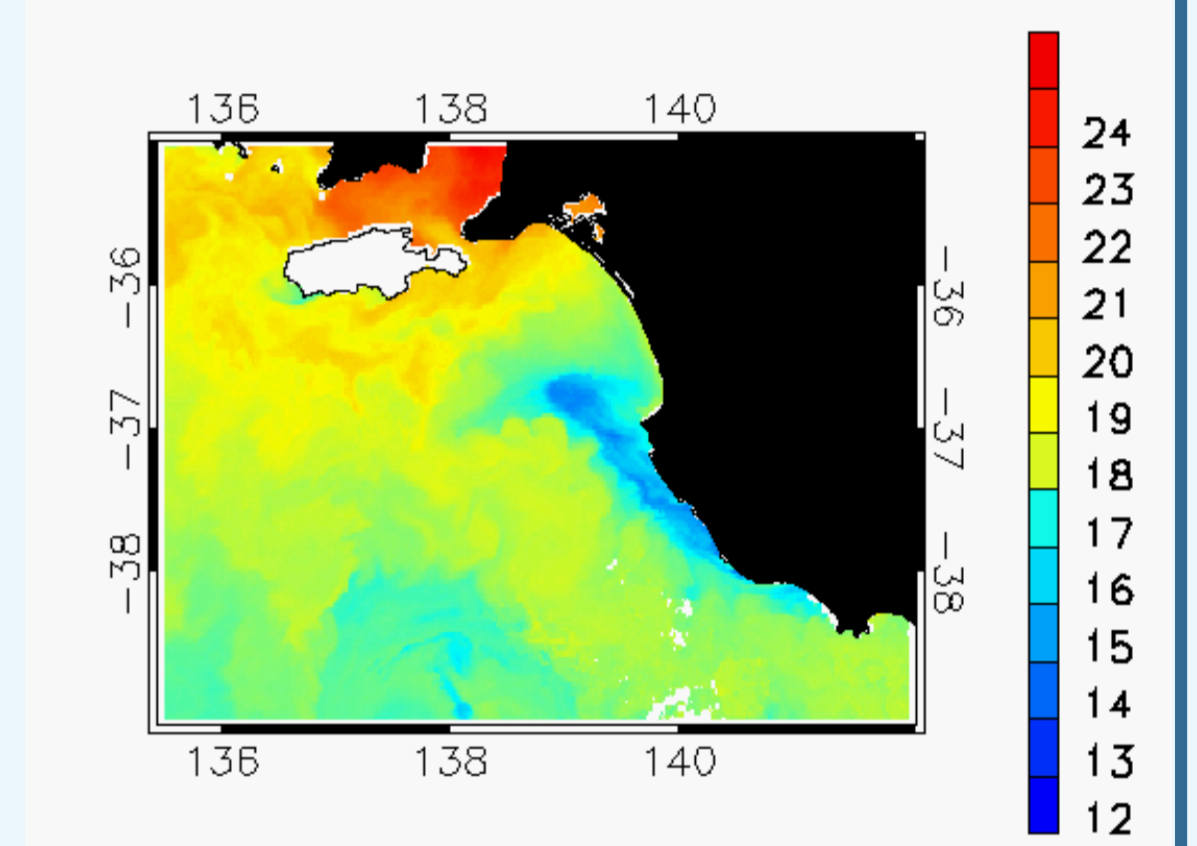
Fig. 7. IMOS OceanCurrent map of the 2 km SST anomaly and surface ocean current vectors for 25th April 2019, South East Australia, generated using IMOS night-only 6-day Multisensor L3S SSTs.



Studying coastal ocean features:

Given the improved spatial coverage of Multi-sensor L3S SSTs, they are useful to identify and study coastal upwelling events in the Australian region.

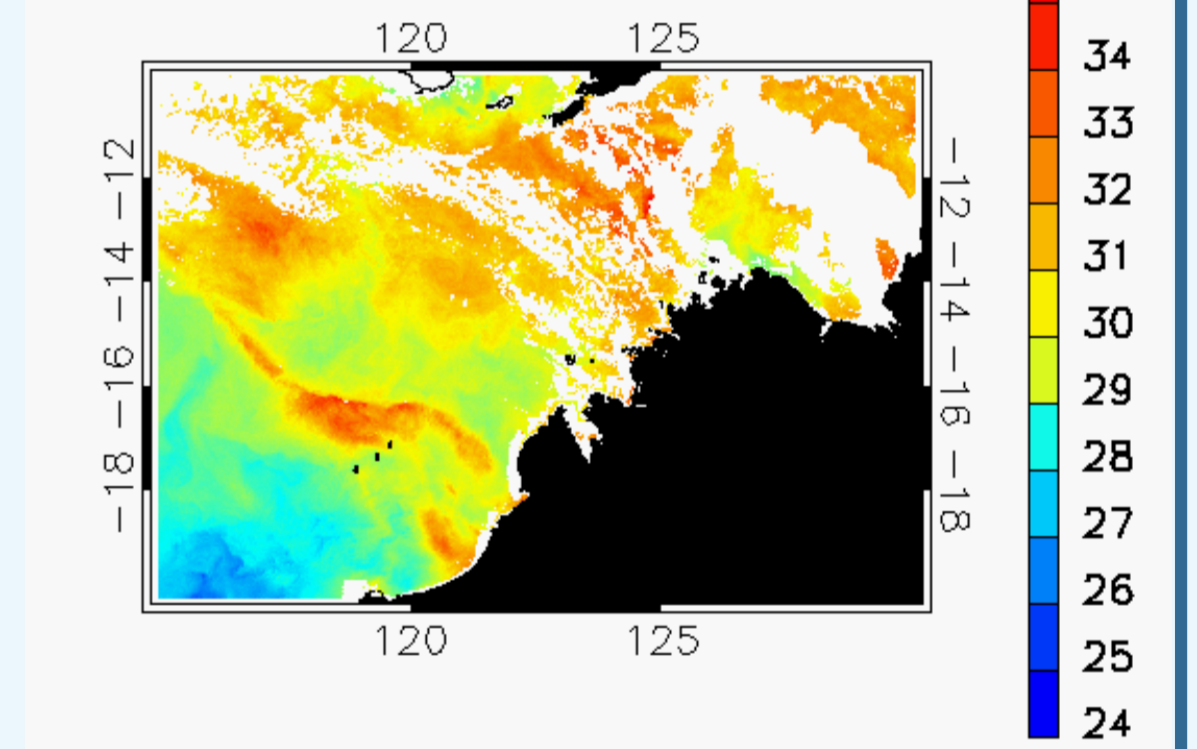
Fig.8 Upwelling Case Study: Bonney Coast 8th March 2018, Multi-sensor L3S-1day night SST (QL ≥ 3).



Studying short-term ocean phenomena:

IMOS Himawari-8 L3C products can be used to study diurnal warming and coastal upwelling, and for coastal model verification etc.

Fig 9. IMOS Himawari-8 hourly L3C SST (QL ≥ 4) for 17th November 2018 at 08:00 UTC (~ 4 pm LT) over the Australian North-west Shelf.



IMOS new Multi-sensor products

Resolution: 0.02° x 0.02°, L3S averaged over 1, 3, 6 days or 1 month for day, night and day+night

Available: Real-time: 1st Jan 2018 to present. Currently reprocessing: 2012-2018.

Inputs: Real-time: SSTs from NOAA-18, Suomi NPP, NOAA-20, MetOp-B. Reprocessed: Additional data from NOAA-15/19/MetOp-A.

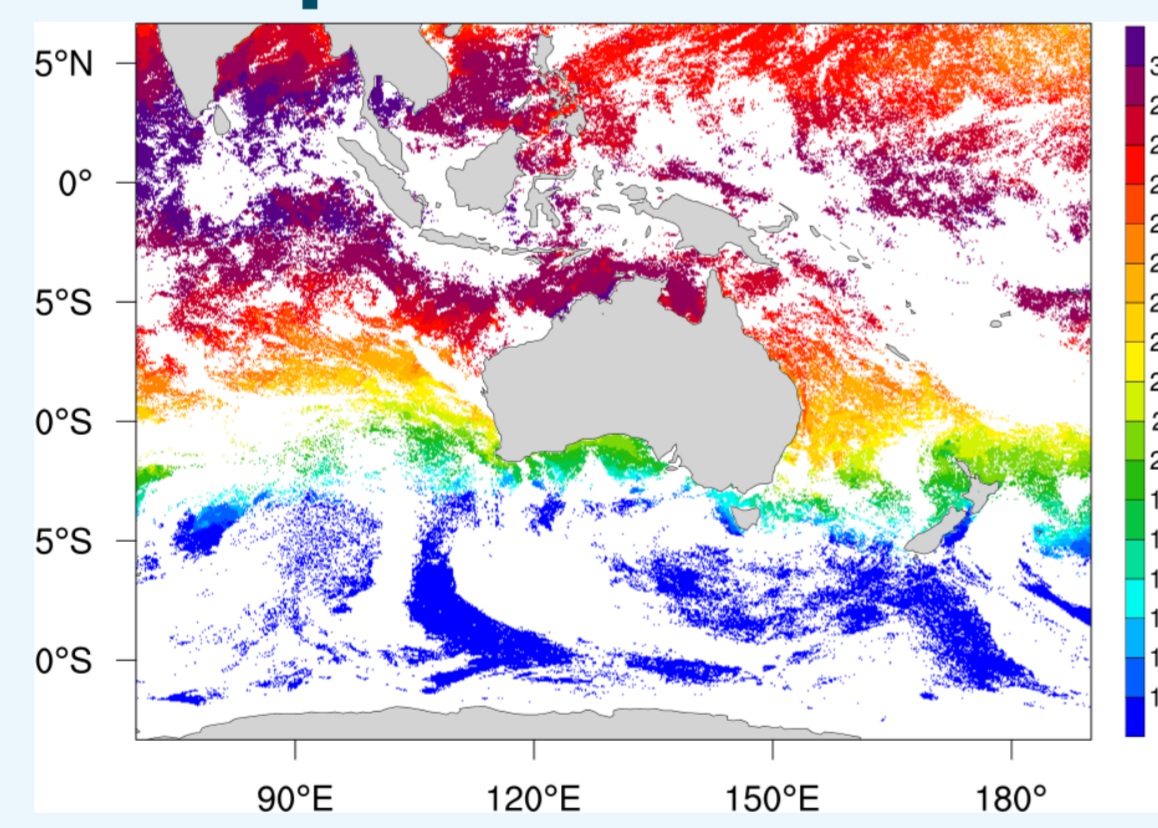


Fig 3. Sea surface temperatures with quality level 4 and 5 for new Multi-sensor L3S-1day night file for 13th April 2019.

IMOS Himawari-8 L3C SST Products

Resolution: Hourly, 4-Hourly and Daily night-time, 0.02° x 0.02°

Available: Real-time: 1st Oct 2017 to present. Aim to reprocess back to July 2015.

Inputs: BoM Himawari-8 L2P SSTskin

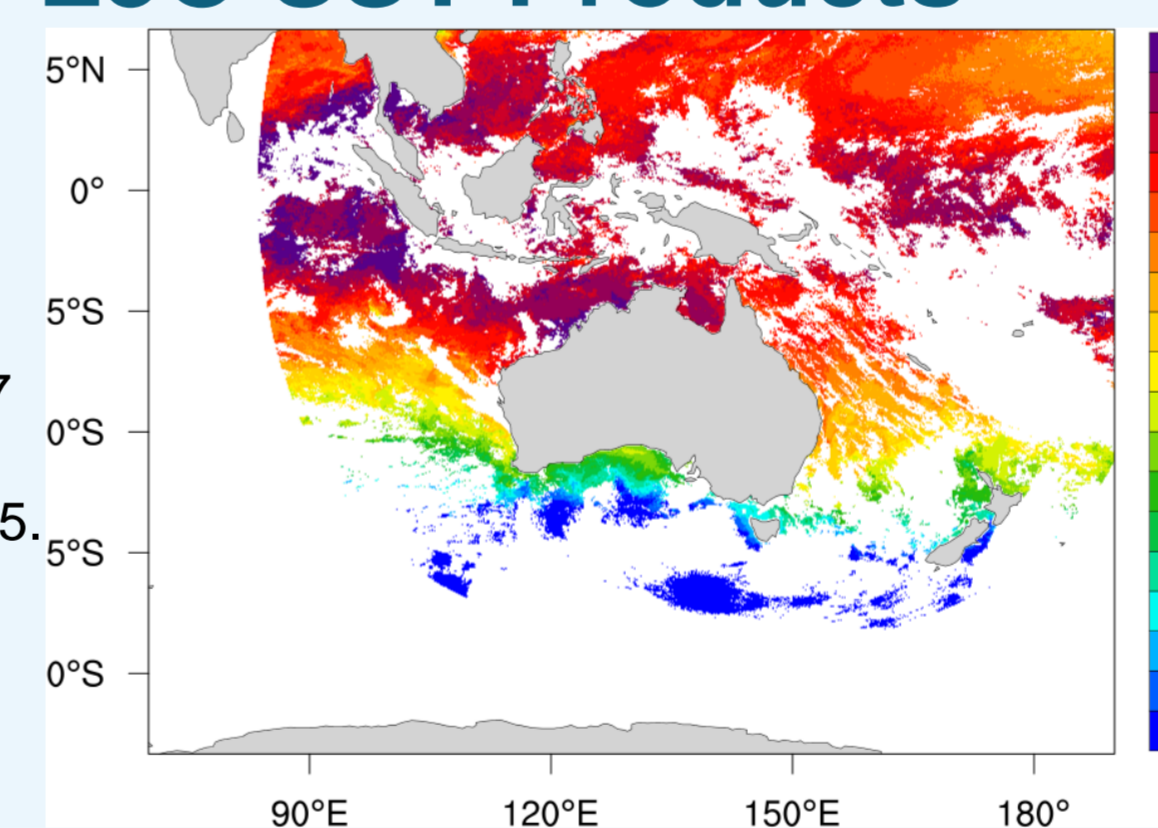


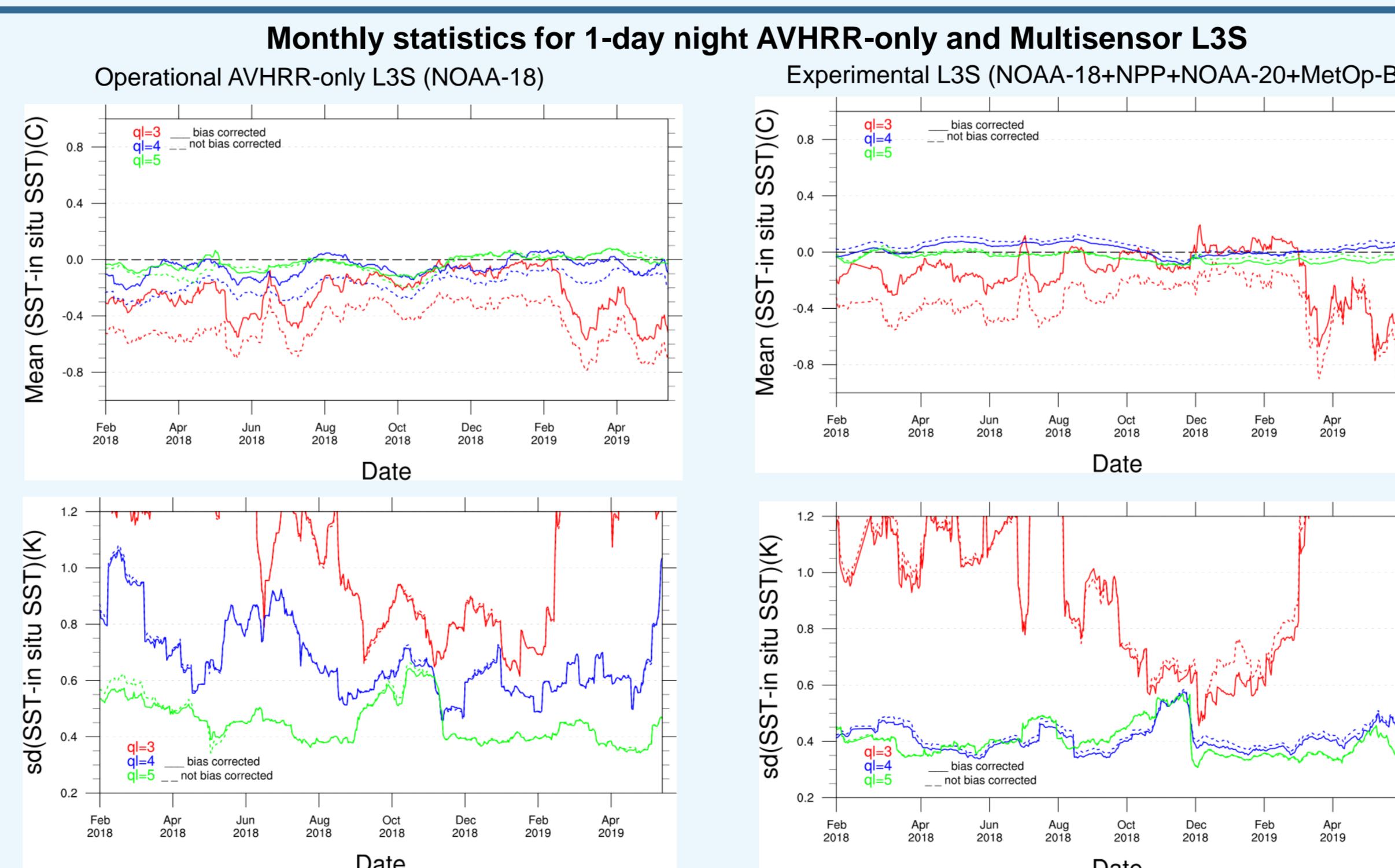
Fig 4. Sea surface temperatures with quality level 4 and 5 for Himawari-8 L3C-1day night file for 13th April 2019

Validation

As an initial validation of the new Multisensor L3S products, we compared quality level (QL) ≥ 3 SST (0.2 m) values from IMOS L3S files with drifting and tropical moored buoy foundation SSTs (0.2m) for the period from 1st Nov 2018 - 8th May 2019 over the Australian domain (70°E - 190°E, 70°S - 20°N). It was found that:

- Experimental Multi-sensor night L3S had more QL ≥ 3 matchups than operational AVHRR only L3S.
- Experimental Multi-sensor L3S shows lower bias and standard deviation values than AVHRR-only L3S SSTs for both day and night.

Fig 5. Validation statistics of the 1-day night operational AVHRR only L3S (left) and experimental Multi-sensor L3S (right) SSTs over a 30-day moving window.



Future Plans

- Over the coming 12 months, we look forward to:
- Validating Multisensor L3S files more extensively
- Reprocessing fv02 IMOS-GHRSSST Multisensor L3S files for the period of 1st January 2012 to 31st December 2018
- Improve cloud mask in Himawari-8 products

Further Information

Email : helen.beggs@bom.gov.au
Web site : <http://imos.org.au/sstproducts.html>

Acknowledgements

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